

REMARKS

Applicants thank the Examiner for the very thorough consideration given the present application. Claims 1-6 are currently pending in this application. No new matter has been added by way of the present amendment. For instance, the amendments to claims 1 and 2 are supported by the Specification at, for example, page 1, lines 9-12. Accordingly, no new matter has been added.

In view of the amendments and remarks herein, Applicants respectfully request that the Examiner withdraw all outstanding rejections and allow the currently pending claims.

Issues Under 35 U.S.C. 112, 1st paragraph

Claims 1-6 stand rejected under 35 U.S.C. 112, 1st paragraph, as failing to comply with the written description requirement. Applicants respectfully traverse.

Specifically, the Examiner asserts that the Specification does not provide support for the claimed limitation "the remaining molecular beam intensity of the first group V element is not less than 1/100 of that in the first step."

Reconsideration is respectfully requested in light of the present amendments. Also, Applicants note that the Examiner's attention is respectfully directed to FIG. 4 in the present application, which shows the change in intensity of the As molecular beam when the As molecular beam is supplied and supply is stopped (see also page 9, lines 16-18). As shown in FIG. 4, the remaining molecular beam intensity is maintained at approximately 600 nA for 10-30 sec., at which time it drops drastically. Subsequently, the intensity declines slightly until it

reaches approximately 6 nA (at $t=50$ sec). Thus, by dividing 600 nA by 6 nA, the lower limit of the remaining molecular beam intensity as claimed can be obtained.

In view of the above, reconsideration and withdrawal of this rejection are respectfully requested.

Issues Under 35 U.S.C. 112, 2nd paragraph

Claims 1-6 stand rejected under 35 U.S.C. 112, 2nd paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter regarded as the invention. Applicants respectfully traverse.

Applicants note that the claims have been amended to address the issues identified by the Examiner. Accordingly, this rejection is moot.

Reconsideration and withdrawal of this rejection are respectfully requested.

Issues Under 35 U.S.C. 103(a)

Claims 1-3 and 5 stand rejected under 35 U.S.C. 103(a) as being obvious over Kashima et al. (JP 07-86162) (hereinafter Kashima '162) in view of Saito (JP 64-073715) (hereinafter Saito '715). Additionally, claims 4 and 6 stand rejected as being obvious over Kashima '162 in view of Saito '715 and Watanabe (U.S. 6,229,162) (hereinafter Watanabe '162). Applicants respectfully traverse.

The Examiner asserts that Kashima '162 teaches a method of forming a heterostructure film comprising supplying a group IIIa and Va material to grow a IIIaVa thin film using gas source molecular beam epitaxy. The Examiner further asserts that Kashima '162 discloses

suspending the supply of the Va group material and further discloses "t2 time discontinuation of the supply of all thin film raw materials to a substrate", in order to terminate growth of the IIIaVa thin film. Additionally, the Examiner asserts that "Kashima et al. teaches a time period t2 where all raw materials are suspended."

The Examiner acknowledges that Kashima '162 fails to teach or suggest halting growth for a period of time until the remaining molecular beam intensity of the first group V element is reduced to 1/10 or less and not less than 1/100 of that in the first step. The Examiner relies on the teachings of Saito '715 to support an assertion that forcibly exhausting remaining group V elements after growth of the first layer would have been obvious to one skilled in the art, in order to "flatten the layer and...to remove superfluous group V elements from the heterointerface to produce a steep heterointerface."

Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, the Examiner must make the factual determinations set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). "[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability." *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v Teleflex Inc.*, 82 USPQ 2d 1385 (U.S. 2007). There must be a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. *Id.* The Supreme Court of the United States has recently held that the "teaching, suggestion, motivation test" is a valid test for obviousness, albeit one which cannot be too rigidly applied. *Id.*

“[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id.* (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

As amended, the present invention is directed, *inter alia*, to an epitaxial growth method comprising (a) a first step of irradiating a molecular beam of at least one of group III elements and a molecular beam of a first group V element to form a first compound semiconductor layer; (b) a second step of stopping the irradiation of the molecular beam of the group III element and the molecular beam of the first group V element and halting growth for a period of time until a remaining molecular beam intensity of the first group V element is reduced to be **in the range of 0.01 to 0.1** of that in the first step; and (c) a third step of irradiating a molecular beam of at least one of the group III elements **to form an etch stopper layer, wherein the semiconductor thin film comprises a high electron mobility transistor structure** (emphasis added) (see, e.g., claims 1 and 2). Applicants submit that the references of record does not teach or suggest a method as claimed.

The primary reference of Kashima '162 discloses an epitaxial growth method comprising: supplying a group III element and a first group V element (“Va”) to form a first semiconductor layer; suspending the supply of the “Va” element temporarily; and, supplying a second group V element (“Vb”). However, Kashima '162 fails to teach or suggest the manufacturing of an etch stopper layer for a HEMT structure, nor improving the etching resistance thereof. Moreover, as correctly acknowledged by the Examiner, Kashima '162 fails to teach or suggest halting growth for a period of time until the remaining molecular beam intensity of

the first group V element is reduced to be in the range of 0.01 to 0.1 of that in the first step. The secondary references fail to cure these deficiencies.

Saito '715 merely discloses growing an ultra thin film crystal of a compound semiconductor, wherein group V elements are forcibly exhausted together with the hydrogen gas sprayed thereto. Applicants respectfully submit that forcibly exhausting group V elements, as disclosed by Saito '162, is not the same or in any way similar to the presently claimed step of "stopping the irradiation of the molecular beam of the group III element and the molecular beam of the first group V element and halting growth for a period of time until the remaining molecular beam intensity of the first group V element is reduced to be in the range of 0.01 to 0.1 of that in the first step."

Moreover, although the method of Saito '715 may be applicable to substrates having relatively small diameters (e.g., 2 inches), this method may not necessarily be designed for large substrates having 4 or more inches of diameter, since the exhausting would result in unevenness. Further, because the spraying amount and direction (of the hydrogen gas) are difficult to control, the method disclosed by Saito '715 cannot be applied with high reliability and stability, thus teaching away from the Examiner's proposed modification.

Evidently, the cited references, alone or in combination, fail to teach or suggest a method as claimed. For this reason alone, these rejections are improper and should be withdrawn. Moreover, Applicants submit that the present invention achieves superior and unexpected results, which rebuts any *prima facie* case of obviousness arguably established by the Examiner.

At page 5 of the Office Action, the Examiner argues that "Kashima et al. also teaches a downtime was carried out for 24 seconds, which would be expected to reduce the remaining

beam intensity to less than 1/10 because applicant teaches stopping for 1 second reduced As beam intensity to about 1/14." However, Applicants submit that the claimed range of "0.01 to 0.1" is critical, and results in superior and unexpected results.

As to the endpoint "0.1", the present inventors have focused on the amount of group V element remaining during epitaxial growth by MBE. As a result, they have developed a novel epitaxial growth method capable of forming a heterointerface with stable properties. Consequently, they have discovered that when an etch stopper layer in an HEMT structure is formed by the epitaxial method of the present invention, it is possible to obtain very high selectivity, and enable fine etching (see page 11, lines 20-23 of the Specification).

The etching resistance of the etch stopper layer comprising a second compound semiconductor layer is dependent on the amount of the first group V element mixed therein. Applicants have discovered, based on experimentation, that when the mixed amount of the first group V element is not more than 0.05 in the composition, the etching rate is not more than 0.10 nm/sec (see FIG. 3), and an etch stopper layer with high selectivity can be obtained. In order to make the amount of As mixed be not more than 0.05 in the composition, it is necessary to start the growth of the InP etch stopper layer after the intensity of the As molecular beam is reduced to 1/10 or less (see page 10 lines 14-25 of the specification).

As noted by the Examiner, Kashima '162 discloses that the downtime t2 is approximately 24 seconds (see also Fig. 2 of Kashima '162). However, in the present invention, the second step merely lasts less than 1 second (see page 9, line 24 to page 10, line 1 of the specification; see also FIG. 4). Evidently, the claimed endpoint of "0.1" is critical and results in superior and

unexpected results. Accordingly, Applicants request reconsideration in view of this *Graham* factor (evidence of secondary considerations).

In view of the above, reconsideration and withdrawal of this rejection are respectfully requested.

Conclusion

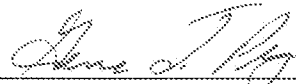
All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding rejections and objections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Vanessa Perez-Ramos, Reg. No. 61,158 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

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Respectfully submitted,

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